Decision Rationale

Total Maximum Daily Loads for
The Primary Contact Use (Bacteriological) Impairments in
The Staunton River Basin, Virginia

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the TMDLs for the primary contact use (bacteriological) impairments in the Staunton River Basin which includes the following impaired segments: Buffalo Creek, Buffalo Creek (Unnamed Tributary), Cub Creek, Staunton River and Turnip Creek. EPA's rationale is based on the determination that the TMDLs meet the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDLs are designed to implement applicable water quality standards.
2) The TMDLs include a total allowable load as well as individual waste load allocations (WLAs) and load allocations (LAs).
3) The TMDLs consider the impacts of background pollutant contributions.
4) The TMDLs consider critical environmental conditions.
5) The TMDLs consider seasonal environmental variations.
6) The TMDLs include a MOS.
7) There is reasonable assurance that the TMDLs can be met.
8) The TMDLs have been subject to public participation.

II. Background

The impaired segments included in the Staunton River Basin are located in Campbell, Charlotte, Halifax and Pittsylvania Counties, Virginia. The total watershed area is 1,477,287 acres. Forested and agricultural lands make-up the majority (94 percent) of the lands within watershed. Developed and transitional lands comprise another three percent of the watershed area.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed several waters in the Staunton River Basin on Virginia's Section 303(d) lists as being unable to attain their applicable criteria. Table 1 documents the impairments and year of initial listing for each listed segment. The decision to list for bacteria (fecal coliform) was based on observed violations of the Commonwealth's bacteriological criteria. At the time of their listing, the bacteria criteria used fecal coliform as an indicator species and had an instantaneous standard 1,000 colony forming units (cfu) per 100 milliliters (ml) and geometric mean standard of 200 cfu/100 ml. This decision rationale will address the TMDLs for the impairments of the primary contact use.

Table #1 – Staunton River Basin TMDL Impairments

Segment	Stream Name	Initial Listing	Impairments
VAC-L37R-01	Cub Creek	2002	Fecal Coliform
VAC-L36R-01	Turnip Creek	2002	Fecal Coliform
VAC-L40R-06	Buffalo Creek	2004	Fecal Coliform
VAC-L40R-05	Buffalo Creek (UT)	2002	Fecal Coliform
VAC-L19R-01	Staunton River	1998	Fecal Coliform
VAC-L40R-03	Staunton River	2002	Fecal Coliform

Fecal coliform is a bacterium which can be found within the intestinal tract of all warm blooded animals. Therefore, fecal coliform can be found in the fecal wastes of all warm blooded animals. Fecal coliform in itself is not a pathogenic organism. However, fecal coliform indicates the presence of fecal wastes and the potential for the existence of other pathogenic bacteria. The higher concentrations of fecal coliform indicate the elevated likelihood of increased pathogenic organisms.

EPA encouraged the states to use e-coli and enterococci as the indicator species instead of fecal coliform. A better correlation was drawn between the concentrations of e-coli and enterococci, and the incidence of gastrointestinal illness. The Commonwealth adopted e-coli and enterococci criteria in January 2003. According to the new criteria, streams will be evaluated via the e-coli and enterococci criteria after 12 samples have been collected using these indicator species. The fecal coliform criteria will be used in the interim. Twelve e-coli samples were collected from the waters addressed under the Staunton River Watershed TMDLs.

As Virginia designates all of its waters for primary contact, all waters are required to meet the bacteriological standard for primary contact. Virginia's standard applies for all flows, there are no high or low flow exemptions. The fecal coliform criteria was modified in 2003 to require that the fecal coliform concentration not exceed a geometric mean of 200 cfu per 100 ml of water for two or more samples collected over a month, nor shall more than 10 percent of the total samples exceed 400 cfu/100 ml of water. The new criteria also established concentration based requirements for e-coli. The e-coli criteria requires a geometric mean concentration of 126 cfu/100 ml of water with no sample exceeding 235 cfu/100 ml of water. Unlike the fecal

coliform criteria, which allows a 10 percent violation rate, the new e-coli criteria requires the concentration of e-coli not exceed 235 cfu/100 ml of water. This caps the allowable concentration of bacteria and requires extremely stringent load reductions for attainment.

Although the TMDLs and criteria require the 235 cfu/100 ml of water for e-coli not be exceeded, waters are not placed on the Section 303(d) list if their violation rate does not exceed 10 percent. Therefore, these waters may be deemed as attaining the primary contact use prior to the implementation of all of their TMDL reductions. It is necessary to keep this in mind because of the reductions required to attain the instantaneous criteria for e-coli in the model.

Through the development of this and other similar TMDLs, it was discovered that natural conditions (wildlife contributions to the streams) could cause or contribute to violations of the bacteria criteria. Bacterial source tracking sampling data collected from the impaired segments within the Staunton River Basin demonstrated that bacteria from wildlife represents a significant portion of the total bacterial load. In some instances, the loads from wildlife alone appear to violate the numeric criteria. Many of Virginia's TMDLs, including the TMDLs for the Staunton River Basin, have called for some reduction in the amount of wildlife contributions to the impacted streams. EPA believes that a significant reduction in wildlife is not practical and will not be necessary due to the implementation plan discussed below. It should be noted that in order for the impaired waters to be in compliance approximately 90 percent of the time, less stringent reductions are required from wildlife sources. This would be the violation rate necessary for the water to be assessed as attaining criteria for 303(d) listing purposes.

A phased implementation plan will be developed for all streams in which the TMDL calls for reductions in wildlife. In Phase 1 of the implementation, the Commonwealth will begin implementing the reductions (other than wildlife) called for in the TMDL. In Phase 2, which can occur concurrently to Phase 1, the Commonwealth will consider addressing its standards to accommodate this natural loading condition. The Commonwealth has indicated that during Phase 2, it may develop a Use Attainability Analysis (UAA) for streams with wildlife reductions which are not used for frequent bathing. Depending upon the result of the UAA, it is possible that these streams could be designated for secondary contact.

After the completion of Phase 1 of the implementation plan, the Commonwealth will monitor the stream to determine if the wildlife reductions are actually necessary, as the violation level associated with the wildlife loading may be smaller than the percent error of the model. In Phase 3, the Commonwealth will investigate the sampling data to determine if further load reductions are needed in order for these waters to attain standards. If the load reductions and/or the new application of standards allow the stream to attain standards, then no additional work is warranted. However, if standards are still not being attained after the implementation of Phases 1 and 2, further work and reductions will be warranted.

The TMDL Report submitted by Virginia is designed to determine the acceptable load of e-coli which can be delivered to the impaired waters, as demonstrated by the use of the

Hydrologic Simulation Program Fortran (HSPF),[1] in order to ensure that the water quality standard is attained and maintained. HSPF was considered an appropriate model to analyze the impaired water because of its dynamic ability to simulate both watershed loading and receiving water quality over a wide range of conditions. The model was run to determine the fecal coliform loading to the impaired tributaries as most of the loading information and sampling results are based on fecal coliform. The in-stream fecal coliform concentrations were then converted to e-coli using a conversion factor established by the Commonwealth.

The TMDL analysis allocates the application/deposition of fecal coliform to land based and instream sources. For land based sources, the HSPF model accounts for the buildup and washoff of pollutants from these areas. Buildup (accumulation) refers to the complex spectrum of dry-weather processes that deposit or remove (die-off) pollutants between storms.[2] Washoff is the removal of fecal coliform which occurs as a result of runoff associated with storm events. These two processes allow the HSPF model to determine the amount of fecal coliform from land based sources which is reaching the stream. Point sources and wastes deposited directly to the stream were treated as direct deposits. Wastes which are deposited directly to the stream do not need a transport mechanism. Local rainfall and temperature data were needed to develop the model. Weather data provides the precipitation data which drives the TMDL model. Weather data was collected from Roanoke International Airport, Lynchburg WSO Airport and the John Kerr Dam weather stations.

Stream flow data was available from United States Geological Survey gages 02059500 and 02066000 on Goose Creek and the Staunton River respectively. Goose Creek is a tributary to the Staunton River. This allowed the modelers to calibrate and validate the hydrologic model to observed flow data within this watershed. The model was calibrated to flow data collected from the gages from January 2000 through December 2001. In the calibration process the model parameters are adjusted until a concurrence between the observed and simulated flows is achieved. To insure that the model is accurately predicting the stream's responses, the model is then compared to a different set of observed flow data. The Staunton River TMDL model was validated to gage data collected from January 2001 through December 2004.

The TMDLs were modeled using fecal coliform loading rates as was done in previous TMDL efforts. The fecal coliform concentrations were then converted to e-coli concentrations using a translator equations developed by VADEQ. Significant reductions in the modeled load were required in order for the Staunton River and its tributaries to attain the e-coli criteria in the model. More stringent reductions were required to meet the instantaneous standard than the

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[1]Bicknell, B.R., J.C. Imhoff, J.L. Little, and R.C. Johanson. 1993. Hydrologic Simulation Program-FORTRAN (HSPF): User's Manual for release 10.0. EPA 600/3-84-066. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

[2]CH2MHILL, 2000. Fecal Coliform TMDL Development for Cedar, Hall, Byers, and Hutton Creeks Virginia,

geometric mean. Table 2 documents the allowable loading to the Staunton River.

Table #2 - Summarizes the Specific Elements of the TMDLs.

Stream Name	TMDL (cfu/yr)	WLA (cfu/yr)	LA (cfu/yr)	MOS (cfu/yr)
Cub Creek	1.53E+12	1.43E+11	1.39E+12	Implicit
Turnip Creek	6.63E+11	1.30E+10	6.50E+11	Implicit
Buffalo Creek	2.06E+11	2.06E+09	2.04E+11	Implicit
Buffalo Creek (UT)	1.65E+10	1.65E+08	1.63E+10	Implicit
Staunton River	7.77E+13	2.34E+13	5.43E+13	Implicit

The United States Fish and Wildlife Service has been provided with a copy of the TMDL Report.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing a primary contact (bacteriological) impairment TMDLs for the Cub Creek, Turnip Creek, Buffalo Creek, Buffalo Creek (UT), and Staunton River Watersheds. EPA is therefore approving these TMDLs. EPA's approval is outlined according to the regulatory requirements listed below.

1) The TMDLs are designed to meet the applicable water quality standards.

Virginia has indicated that excessive levels of fecal coliform due to nonpoint sources (both wet weather and directly deposited nonpoint sources) have caused violations of the water quality criteria and designated uses on Cub Creek, Turnip Creek, Buffalo Creek, Buffalo Creek (UT), and Staunton River. The water quality criterion for fecal coliform was a geometric mean 200 cfu/100 ml or an instantaneous standard of no more than 1,000 cfu/100 ml. Two or more samples over a 30-day period are required for the geometric mean standard. Since the state rarely collects more than one sample over a thirty-day period, most of the samples were measured against the instantaneous standard. According to the 2004 Section 303(d) list, the violation rate for these waters was between 15 and 50 percent.

The Commonwealth has changed its bacteriological criteria as indicated above. The new criteria require that the fecal coliform concentration not exceed a geometric mean of 200 cfu per 100 ml of water for two or more samples collected over a month nor shall more than 10 percent of the total samples exceed 400 cfu/100 ml of water. The new e-coli criteria requires a geometric mean of 126 cfu/100 ml of water with no sample exceeding 235 cfu/100 ml of water.

The HSPF model was used to determine the fecal coliform deposition rates to the land as well as loadings to the stream from direct deposit sources. Once the existing load was determined, allocations were assigned to each source category to develop a loading pattern that

would allow Beaver Cub Creek, Turnip Creek, Buffalo Creek, Buffalo Creek (UT), and Staunton River to support the e-coli water quality criterion and primary contact use. The following discussion is intended to describe how controls on the loading of e-coli to these waters will ensure that the criterion is attained.

The TMDL modelers determined the fecal coliform production rates within the watershed. Data used in the model was obtained from a wide array of sources, including farm practices in the area, the amount and concentration of farm animals, animal access to the stream, manure application rates, wildlife in the watershed, wildlife fecal production rates, landuses, weather, stream geometry, etc.. The model combined all of the data to determine the hydrology and water quality of the stream.

The lands within the watersheds were categorized into specific landuses. The landuses had specific loading rates and characteristics that were defined by the modelers. Therefore, the loading rates are different in lands defined as forested versus pasture. Pasture lands support cattle and are influenced differently by stormwater runoff.

The Cub Creek, Turnip Creek, Buffalo Creek, Buffalo Creek (UT), and Staunton River TMDL models were run using weather data collected from local National Climatic Data Center weather stations. The stations were Roanoke International Airport, Lynchburg WSO Airport and John H. Kerr Dam. The data from each station was weighted based on their proximity to the watershed segment. The weather data was used to determine the precipitation rates in the watersheds which transports the on land pollutants to the streams through overland and groundwater flows. Waste that was deposited to the land or stored was subjected to a die-off rate. The longer fecal coliform stayed on the ground the greater the die-off was. Materials that were washed off the surface shortly after deposition were subjected to less die-off.

As stated above the model for the Staunton River TMDL was calibrated and validated to USGS gage data collected within the watershed. The gage data used for calibration and validation was collected from 2000 through 2004. The water quality models were calibrated and validated against observed data collected from each of the streams.

2) The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest and agricultural land segments) and point sources. Activities that increase the levels of bacteria to the land surface or their availability to runoff are considered flux sources. The actual value for total loading can be found in Table 2 of this document. The total allowable load is calculated on an annual basis.

Waste Load Allocations

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR § 122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR § 130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Virginia has stated that there are 29 individually permitted facilities and 5 residential permitted facilities discharging bacteria within the Cub Creek, Turnip Creek and Staunton River Watersheds. There are no permitted facilities discharging bacteria in the Buffalo Creek or Buffalo Creek (UT) Watersheds. However, a WLA was provided in each of these watersheds to account for future growth. The WLA for the permitted facilities can be found in Table 5-15 of the TMDL Report and Table 1 of the April addendum to the TMDL. None of these facilities were required to reduce their loading since they are permitted to discharge at criteria The WLAs for these facilities was determined by multiplying the permitted flow by the permitted bacteria concentration by 365 days.

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), LAs are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings, VADEQ used the HSPF model to represent the impaired watersheds. The HSPF model is a comprehensive modeling system for the simulation of watershed hydrology, point and nonpoint source loadings, and receiving water quality. HSPF model used precipitation data for continuous and storm event simulation to determine total loading to the impaired segments from the various landuses within the watersheds. Tables 4a-f list the LAs for impaired segments within the Staunton River Basin. The reductions needed to insure that the instantaneous criteria are attained at all times are extremely stringent.

Table 4a - LA for Bacteria (fecal coliform) for Cub Creek

Source Category	Existing Load (cfu/yr)	Proposed Load (cfu/yr)	Percent Reduction
Forest	6.75E+11	3.38E+10	95
Agriculture	4.00E+12	1.99E+11	95
Developed	5.99E+12	3.00E+11	95

Water/Wetland	9.63E+09	4.81E+08	95
Failed Septic – Direct Deposition	5.04E+11	0.00	100
Wildlife – Direct Deposition	3.22E+11	9.66E+11	70
Cattle – Direct Deposition	1.83E+12	0.00	100

Table 4b - LA for Bacteria (fecal coliform) for Turnip Creek

Source Category	Existing Load (cfu/yr)	Proposed Load (cfu/yr)	Percent Reduction
Forest	2.39E+11	2.39E+10	90
Agriculture	1.70E+12	1.70E+11	90
Developed	1.09E+12	1.09E+11	90
Water/Wetland	4.10E+09	4.10E+08	90
Failed Septic – Direct Deposition	2.64E+11	0.00	100
Wildlife – Direct Deposition	1.19E+12	3.57E+11	70
Cattle – Direct Deposition	6.66E+11	0.00	100

Table 4c - LA for Bacteria (fecal coliform) for Buffalo Creek

Source Category	Existing Load (cfu/yr)	Proposed Load (cfu/yr)	Percent Reduction
Forest	6.47E+10	6.47E+10	0.00
Agriculture	7.69E+11	1.54E+10	98
Developed	6.67E+10	6.67E+09	90
Water/Wetland	1.39E+09	1.39E+09	0.00
Failed Septic – Direct Deposition	2.64E+11	0.00	100
Cattle – Direct Deposition	2.42E+11	0.00	100
Wildlife – Direct Deposition	3.94E+11	1.18E+11	70

Table 4d - LA for Bacteria (fecal coliform) for Buffalo Creek (UT)

Source Category	Existing Load (cfu/yr)	Proposed Load (cfu/yr)	Percent Reduction

Forest	9.88E+09	1.96E+08	98
Agriculture	1.10E+11	2.18E+09	98
Developed	8.19E+07	1.62E+06	98
Wildlife – Direct Deposition	4.70E+10	1.40E+10	70

Table 4e - LA for Bacteria (fecal coliform) for Staunton River

Source Category	Existing Load (cfu/yr)	Proposed Load (cfu/yr)	Percent Reduction
Forest	7.79E+12	1.95E+12	75
Agriculture	5.45E+13	1.36E+13	75
Developed	1.07E+14	2.69E+13	75
Water/Wetland	1.03E+11	2.58E+10	75
Failed Septic – Direct Deposition	2.60E+13	0.00	100
Cattle – Direct Deposition	1.77E+13	0.00	100
Wildlife – Direct Deposition	3.93E+13	1.18E+13	70

All of the TMDLs have been developed with a stage 1 implementation goal. The stage 1 reduction goal is for the water to violate the geometric mean criteria less than 10 percent of the time. None of the waters required wildlife controls to meet their stage 1 implementation goals.

3) The TMDLs consider the impacts of background pollution.

The TMDLs consider the impact of background pollutants by considering the bacteria load from background sources like wildlife and calibrating the model to observed conditions which naturally include background sources.

4) The TMDLs consider critical environmental conditions.

According to EPA's regulation 40 CFR § 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the impaired segments is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be

undertaken to meet water quality standards[3]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum.

The HSPF models were run over a multi-year period that exhibited a wide range of climatic conditions. The allocations developed in the TMDLs will therefore insure that the criterion is attained over a wide range of environmental conditions including wet and dry weather conditions.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow and loadings as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods.

Bacteria loadings also change during the year based on crop cycles, waste application rates, and cattle access patterns. Consistent with our discussion regarding critical conditions, the HSPF model and TMDL analysis effectively considered seasonal environmental variations through the use of observed weather data over an extended period of time and by modifying waste application rates, crop cycles, and livestock practices.

6) The TMDLs include a margin of safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL. Virginia included an implicit MOS in the TMDLs through the use of conservative modeling assumptions in the determination of bacteria loadings and production.

7) There is a reasonable assurance that the TMDLs can be met.

EPA requires that there be a reasonable assurance that the TMDLs can be implemented.

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[3]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

WLAs will be implemented through the NPDES permit process. According to 40 CFR § 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program.

8) The TMDLs have been subject to public participation.

Two public meetings were held for the Staunton River Basin TMDLs (Cub Creek, Turnip Creek, Buffalo Creek, Buffalo Creek (UT) and Staunton River). The meetings were held on September 2, 2004 and January 23, 2006. Both meetings were held in the Town of Brookneal and noticed in the Virginia Register for a 30-day comment period. Ten people attended the first meeting and 22 attended the second meeting.